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OBSERVATIONS ON *GELIDIUM PUSILLUM* (STACKH.) LE JOLIS (RHODOPHYTA) FROM THE COAST OF PAKISTAN

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Abstract

The vegetative, anatomical and reproductive structures of the Pakistani populations of *Gelidium pusillum* (Stackhouse) Le Jolis have been investigated. The plants showed distinctive features with turf or cushion forming habit; upto 11 mm in length and appear distinctly segmented in microscope; primary erect fronds tereto-compressed below becoming flat in the upper half; random arrangement of surface cells as well as tetrasporangia; tetrasporangia borne in stichidia-like structures as well as on the tips of branch fronds; sexual plants not found; and abundance of rhizines.

Introduction

Gelidium pusillum (Stackhouse) Le Jolis has not been extensively studied from Karachi (Anand, 1943), Lasbela (Shameel & Afaq-Husain, 1987; Shameel *et al.*, 1989), Makran (Shameel *et al.*, 1996) and other coastal areas of Pakistan (Shameel & Tanaka, 1992). There exists very little or no taxonomic data, which makes its identification difficult. Moreover, the identification of gelidiaceous taxa is very difficult due to a high degree of intraspecific variations (Feldmann & Hamel, 1936; Dixon & Irvine, 1977; Felicini & Perrone, 1994; Freshwater & Rueness, 1994). The previous reports on *G. pusillum* from the coasts of Pakistan (Anand, 1943) and the adjoining countries of India, Iran and Sri Lanka (Bϕrgesen, 1933, 1935, 1939; Durairatnum, 1961) carry insuffient descriptions, which appear to be based on poor studies of scanty materials. In the present work the populations of *G. pusillum* from different areas of Pakistan have been studied to provide a complete systematic account which were found to differ from the descriptions of Stackhouse (1759) and Fredriksen *et al.*, (1994) in few respects.

Materials and Methods

Algae were collected as epilithon from lower littoral rocks at Buleji, Paradise Point and Cape Monze near Karachi and also from Gadani and Sonmiani at the coastal areas of Lasbela, Pakistan, during July 1985 - December 1993. Some specimens were fixed in 4% formalin-seawater solution and others mounted on herbarium sheets which are kept in the Herbarium of PCSIR, Karachi (CLH) and Seaweed Herbarium, MAH Qadri Biological Research Centre, University of Karachi (KUH-SW). The staining of whole plants or parts of them was carried out in 1% aniline blue for 24-72 h and sectioning was done either by free hand cutting or by an ordinary rotary microtome. To study cell morphology the fronds were treated with 10% HCl containing a few drops of

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1% aniline blue for 2-4 days and then squashed by gentle tapping under a cover slip in a suitable medium. For quick staining the sections or pieces of fronds were treated with a mixture of glycerine + acetic acid + distilled water (1:1:1, v/v), to which a few drops of 1% aniline blue were added. Temporary slides were prepared in the above mentioned mixture and permanent slides in Karo syrup.

Results

References: Stackhouse 1795: 16, Bφrgesen 1933: 114, 1935: 42, 1939: 105, Feldmann & Hamel 1936: 112, Anand 1943: 11, Durairatnam 1961: 50, Abbott & Hollenberg 1976: 347, Jassund 1976: 71, Dixon & Irvine 1977: 129, Stewart & Norris 1981: 275, Lee 1988: 12; 1994: 72, Rodriguez & Santelices 1988: 118, Santelices 1988: 102, Hatta & Reine 1991: 364, Aleem 1993: 67, Lee & Kim 1995: 167.

The Pakistani populations of *G. pusillum* which grow in small turfs are caespitose, upto 11 mm long. Creeping filaments are cylindrical, upto 0.3 mm thick, consisting of broader cells than in erect fronds. Erect axes are cylindrical at the base, gradually turning to be compressed and then flattened in the upper part of the segment, cylindrical part upto 0.24 mm thick and flat part upto 0.6 mm broad and 0.1 mm thick; branching mostly by regeneration of fronds at shedded or broken ends. Apical cell is conico-discoid, protruding beyond the adjacent cortical cells, the surface cells are roundish-angular with random orientation in the middle part of erect fronds. Tetrasporangia occur in sori at the tip of erect fronds or in stichidia-like structures, oriented randomly and borne on 3rd or 4th cell of the cortical filaments. Details of these characters are as follows:

Morphological characters: Plants grow in small, dense, low turfs or cushions of about 5 cm diam., or larger due to close development of 2 or more cushions. Their colour is brownish red to blackish maroon but sometimes appears greenish due to growth of epiphytic *Ulva* youngsters. The cushions are upto 5 mm thick and consist of creeping and erect systems. The creeping system is thread-like, cylindrical, 0.1-0.3 mm in diam., irregularly branched with conical apices, and is attached to substratum by small attaching pads. The latter are issued at small intervals on lower side, upto 300 μm long and as broad as the creeping axes, and are made up of elongated cells (Figs. 1 & 2). The creeping axes give rise to upright fronds (usually at places opposite to attaching pads), which are upto 11 mm long, intermingled into small cushions. The uprights arise as cylindrical branches with conical apices gradually turning to tereto-compressed, upto 0.25 mm thick and finally become flat, upto 0.6 mm wide x 0.1 mm thick.

Several axes arise from the basal part of an upright axis, so that it appears like a small tuft in the microscope, 1 or 2 such axes become prostrate and behave as a part of creeping system, similarly the end branches of the creeping system may turn up and behave as upright ones. Branching is irregular, from any part of thallus except flat surface, spursed to conjusted. Regeneration of the axes at broken or shedded surface is a common way of branching; upto 7 branch fronds are seen arising from broken surface of remnant axes. Such branching occurs 2-4 times so that the plant becomes conjusted distally and the fronds appear to consist of a series of 2-5 segments, probably each representing a season of growth. In favourable season tetrasporic sori develop at the tip

of fronds, which disintegrate after shedding of spores, and new branch fronds arise from this place in the next season, the branch fronds in turn, behave in a similar way (Figs. 1 & 2). The branch initials are terete with tapering tips, irrespective of their place of origin (either from terete or flat axis) and they turn into compressed or flat frond at any stage of their further development.

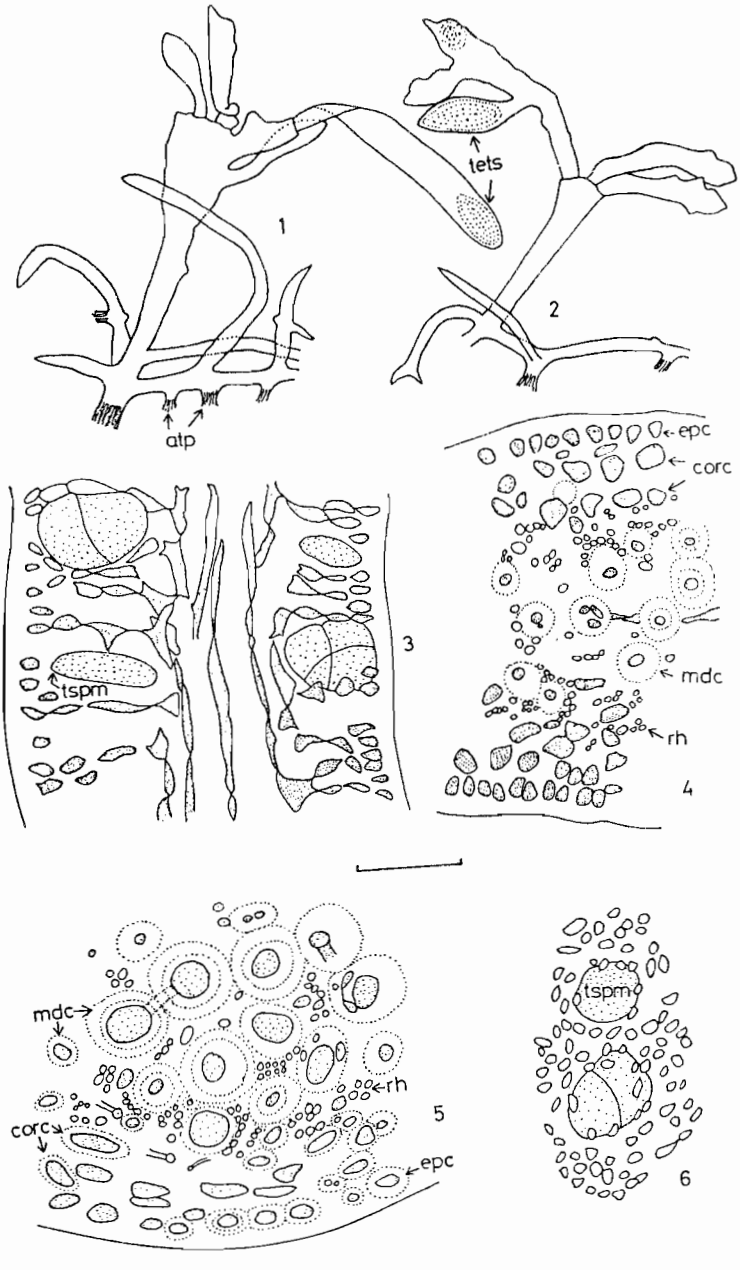
Anatomical features: The cross sections (C.S.) of the basal, middle and upper parts of erect fronds are circular, ellipsoid (upto 240 μm thick) and linear (upto 108 μm thick) in outline respectively. The C.S. of the younger fronds are also ellipsoid in outline showing that the upright axes arise as cylindrical branches which gradually become flat distally. The cortex is 2-3 cell layers thick; peripheral cells 5-7 μm long or broad, usually slightly longer than broad, and are arranged with their long axis at right angle to surface; the inner cortical cells become upto 9 μm long or broad. The cells below the cortex become broader and longer towards interior but small and large cells are interspersed and they lie along the long axis of the thallus. These medullary cells are upto 148 μm long x 16 μm broad, they are round to oblong in C.S. and their walls are thick and colourless, not visible easily; their cytoplasmic portion gets stained with aniline blue and appears irregular in diameter which is upto 6 μm long (Fig. 4). Rhizines are present in large number below the cortex, decreasing towards interior, and are upto 360 μm long x 2-5 μm broad with tapering conical ends.

The C.S. of creeping axes is circular, 210 μm in diam., consisting of larger cells than in erect frond. The cortex is 2-3 cell layers thick, its cells are oblong and lie parallel to the surface. The epidermal cells are upto 12 μm long x 10 μm broad. The medullary cells appear round in C.S. with much thicker walls, upto 26 μm in diam., here the walls also appear striated. Rhizines are abundant below the cortex but become scanty in the middle (Fig.5).

Reproductive structures: Only tetrasporic plants were found (Figs. 1 & 2). The sori develop at the tip of flat fronds (Fig. 1) or in stichidia-like structures which arise from lateral margin of flat fronds. These are unbranched and ellipsoid in outline (Fig. 2). The frond may remain unbranched at sorus or may give rise to small pinnule-like branches apically or laterally. The sorus is 350-620 μm long at the tip of frond and as broad as the thallus with a narrow, 10-20 μm broad sterile margin and slightly thicker than vegetative axes. The tetrasporangia of different ages are interspersed, easily observed in surface view (Fig. 6), and measure upto 29 μm long x 21 μm broad. In longitudinal section (L.S.) of tetrasporic sorus, the cortical filaments are 3-4 cells long, cells 12 μm x 5 μm. The tetrasporangium arises from 3rd or 4th cell of the cortical filaments, it elongates first and then broadens becoming upto 43 μm long x 31 μm broad, on maturity it divides cruciately into four tetraspores (Fig. 3). The tetrasporangia are found only with periclinal division or both priclinal and anticlinal divisions; the anticlinal divisions are usually in different planes in each half, showing that the first division is always periclinal and second anticlinal division is independent of each other in each half.

Specimens examined: Buleji (*Leg.* M. Shameel 5-7-1985, 18-10-1990, 8-12-1993), Paradise Point (*Leg.* S. Afaq-Husain 20-12-1987, M. Shameel 15-10-1988), Cape Monze (*Leg.* S. Afaq-Husain 8-9-1985, M. Shameel 23-11-1989), Gadani (*Leg.* S. Afaq-Husain 27-7-1986, Sonmiani (*Leg.* S. Afaq-Husain 17-9-1985).

Habitat: Epilithic on lower littoral rocks.



Figs. 1-6. *Gelidium pusillum* (Stackhouse) Le Jolis: 1 & 2. Plants showing habit. 3. Longitudinal section (L.S.) of tetrasporic sorus. 4. A part of cross section (C.S.) of terete, erect frond showing cellular details. 5. A part of C.S. of creeping frond showing cellular details. 6. Surface view of tetrasporic sorus. (atp = attaching pads, corc = cortical cell, epc = epidermal cell, mdc = medullary cell, rh = rhizine, tets = tetrasporic sorus, tspm = tetrasporangium; Scale for figs. : 1 & 2 = 1.2 mm, 3-6 = 38 μm)

Discussion

Comparing with the original description of Stackhouse (1795) and the recent one of Fredriksen *et al.*, (1994), the Pakistani populations of *G. pusillum* differ in the following characters: (1) **Habitat:** Fredriksen *et al.*, (1994) have characterised *G. pusillum* to grow on open rocks in upper and mid littoral but Pakistani populations are only found in lower littoral zone probably to protect themselves from heat and sun. Khafaji *et al.*, (1989) also reported abundant occurrence of *G. pusillum* in very shallow, rocky mid-littoral zone of Mersa Al-Hussain, Furasan Archipelago, Saudi Arabia, where they form a turf and dominate over other minute algae. (2) **Size of plants:** According to Fredriksen *et al.*, (1994: 464-465, Figs. 4 & 8) their plants are 5-30 mm long and upto 1 mm broad, but in Pakistan they are upto 11 mm long and 0.6 mm broad. (3) **Texture and colour:** Stackhouse (1795) described *G. pusillum* to be rigid and horny in substance and pale red in colour when seen in light. Our specimens are tough in texture but not rigid and horny, blackish maroon in colour and not pale. Khafaji *et al.*, (1989) also observed Saudi Arabian plants as not rigid and horny. (4) **Shape of fronds:** According to Stackhouse (1795) and Fredriksen *et al.*, (1994: 464, Fig. 1) the erect fronds are spathulate, produce branches in the form of forks or horns which appear constricted or stalked at the base. In our collection, the plants consist of both terete and flat fronds, the terete branches usually turn into flat thalli gradually and do not appear constricted or stalked at the base. (5) **Striations:** No striation on any part of fronds was found as reported about European plants (Fredriksen *et al.*, 1994), however longitudinal chains of medullary cells have been observed inside fronds when examined under microscope. (6) **Mode of branching:** Primarily the branching is lateral and does not appear forked as described by Stackhouse (1795) and Fredriksen *et al.*, (1994). However, terminal branching occurs only from broken surface of remnant fronds and may appear forked; the emergence of new branches from broken surface is a common way of branching in our specimens due to which they appear jointed. (7) **Shape of branches:** Stackhouse (1795) and Fredriksen *et al.*, (1994) described the branches of their plants to be rounded or ovoid whereas in our specimens they are distinctly conical. However, the tips of flat branch fronds become obtuse in due course of development.

The differences observed in the Pakistani populations from the type description of *G. pusillum* are indicative that they probably constitute a distinctive variety of their own. This may be ascertained by further studies.

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